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November 15, 2004

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This is to certify that a professional translator on our staff who is skilled in the French language translated the enclosed French Patent Application No. 2700174 A1 from French into English.

We certify that the attached English translation conforms essentially to the original French language.

Kim Vitray
Operations Manager

Subscribed and sworn to before me this 15th day of November, 2004.

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French Patent Application No. 2 700 174 A1

Job No.: 6495-100342 Ref.: FR2700174
Translated from French by the Ralph McElroy Translation Company
910 West Avenue, Austin, Texas 78701 USA

REPUBLIC OF FRANCE
NATIONAL INSTITUTE OF INDUSTRIAL PROPERTY
PATENT APPLICATION NO. 2 700 174 A1

Int. Cl.^{5}:	C 22 C 38/44 B 62 K 3/00 11/00
Filing No.:	93 00204
Filing Date:	January 7, 1993
Date of Public Access to the Application:	July 8, 1994 Bulletin 94/27
List of the documents cited in the preliminary search report:	Refer to the end of the present specification

MATERIALS AND METHODS FOR PRODUCING LOAD-BEARING STRUCTURES, AND THEIR ACCESSORIES, PRESENTING HIGH MECHANICAL AND CORROSION RESISTANCE PROPERTIES, NOTABLY IN THE FIELD OF CYCLES

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Selection of materials and methods to produce components of load-bearing structures, particularly for cycles, and their accessories.

Characterized by the selection and the use of iron-chromium-based metal materials, which present high mechanical and corrosion resistance properties, as well as by certain manufacturing and assembly methods.

The present invention concerns the construction, materials and methods of apparatuses, their components and their accessories, which are either equipped with wheel(s), such as wheelbarrows, carts, bicycles, tricycles, motorcycles, quadricycles, or skidding devices such as skis, luges, sleds, or aquatic devices such as boards or sailboat(s) or flying systems such as kites, delta foils, gliders, where all these devices are for one or several users, and the driving or supporting force is due to gravity or muscle work, or of aerothermal, thermal or electric origin.

All comprise, in a possible partial and nonlimiting manner, chassis, skids, mats, frames, rims, spokes, bracing wires, hubs, axles, tubes for seats, handlebars, cranks, chains, protectors such as mud guards, cables, engaging connection parts, fastenings, sometimes specialized accessories such as rods, paddles, poles, which are subject to mechanical stresses and to corrosion, in a gaseous or liquid or pasty or solid medium, at temperatures which can vary from -50°C to +50°C.

This invention also concerns stationary, load-bearing structures, supporting plant, animal or polymer sheets, which are intended to provide cover, such as parasols, awnings, windbreakers or umbrellas.

In this text, we assign an elastic limit of 0.2% residual elongation to the concept of the mechanical resistance property.

To describe the invention in a concrete manner, we will make reference more specifically to an example, although in a nonlimiting manner; this example is very well known and very widespread, a bicycle frame made from cylindrical tubes with a circular generating line, or from any other closed shape, or from profiled parts, that is, cylindrical surfaces with open generating lines, or from blanks which are deformed in all directions of space.

The calculation note pertaining to the characteristic parameters, enclosed as Appendix 1, thus relates to cylindrical tubular structures; it is intended to emphasize the magnitudes which demonstrate the advantage of the invention, in comparison to the current technological context.

The metals are referred to using known conventions, their name or their symbol; to facilitate the understanding, the alloys are for the most part named using the AFNOR naming standard, in an indicative manner, that is, without referring to any standard which determines the composition precisely; the composition is described and claimed in an independent manner as far as its significant or conventionally dosed elements are concerned.

Most frequently, and at the lowest commercial cost, one uses for the production of these structures carbon steels whose content of each alloy element, such as chromium, nickel, molybdenum, tungsten, vanadium, is at the level of the residuals which are known for steels produced in the electrical furnace from recycled scrap metal, that is, the level is less than 1% and variable. They do not lend themselves to the application of thermal treatments to confer predetermined mechanical characteristics to them; their resistance, approximately 400 MPa, is in fact obtained by the cold hammering resulting from their cold shaping, notably by impact, hammering, wire drawing, drawing, pilgrim cold rolling, flow spinning or burnishing, with the drawback that, in the case of the assembly of the constitutive elements of the structure, by soldering or brazing or hot fitting, in the area affected by the temperature, the cold hammering disappears, and the resistance drops to a value on the order of 200 MPa: it is well known that bicycle frames which have been assembled under these conditions break in these areas. In

addition, these carbon steel structures must be protected against corrosion, by various paints, lacquers, enamels, galvanic coatings, but all the solutions remain vulnerable to scratching and shocks. This implies, and this fact is well known to the user, that every four years on average, the surface protections need to be restored, requiring sanding, stripping, operations which remove thicknesses on the order of 0.2 mm, and which can represent an expenditure on the order of 30% of the initial purchasing price. One should also note that these protections are easy to apply only if they are external and that the interior of the elements remains completely exposed to corrosion in a confined environment, which is even more damaging, and causes destruction of the structure, possibly rapidly in some atmospheres. This technology, which is economic at the time of purchasing, can be dangerous for the safety of the user because its deterioration is not necessarily visible. The ratio of resistance to a specific weight, E0.2/Msp is very low in the areas which have been treated the most poorly: E0.2/Msp = 200/8 = 25. One can estimate the monetary commercial cost of the products of this technique to be one-fourth of that of the second technology which is described below.

Indeed, in a more efficient manner, carbon steels with low alloy content achieved by the controlled additions are used, where the additives consist of elements such as chromium, molybdenum, vanadium, tungsten, and the total of the contents pertaining to these elements, and expressed in %, does not exceed 5%, in general. For these steels, the mechanical properties are obtained in a reliable and controlled manner, by the thermal treatments of quenching and tempering. Thus, for 25CD4, which is routinely used, a resistance on the order of 800 MPa can be guaranteed and maintained in the assembly areas. With regard to corrosion, this material has to be protected by the same methods as with simple carbon steel. The small thicknesses, for example 0.6 mm, which the good properties of this type of steel may allow, make it impossible to repair surface protections, whose effect is to reduce the thicknesses. This type of construction, which is carried out according to the rules of the art, provides a better guarantee of safety; the ratio E0.2/Msp = 800/8 = 100; we use it as reference solution for the comparisons with the other technologies used. Another routine alternative consists in using aluminum alloys which have been hardened by precipitation. At ambient temperature and under stress, the aging continues, and it can lead to fragility. The mechanically useful lifespan is not limitless. These materials do not require protections against corrosion as imperatively as mentioned for the carbon steels; however, because the action of the atmosphere can be reflected in pitting and darkening, anodization treatments, a technique which is appropriate for aluminum and its alloys, can be applied. The alloy AU4SG is representative of this type of material. The resistance is 400 MPa for a specific weight on the order of 2.7; the ratio E0.2/Msp consequently reaches the value 150, at a commercial cost which is 3-4 times higher than the reference technique with 25CD4. The alloy AU4G1 allows a ratio of E0.2/Msp = 440/2.7, or approximately 160, at the cost of more

difficult use. According to the example cited in Appendix 1, one can see that in this type of alloy, for a level of strength and a similar resistance-strength compromise, one obtains, in comparison to the reference technique, a slight reduction in the weight or even a slight excess weight, which is observed with so called high-range products. The alloys of the 7000 series comprise zinc and chromium, for example, the alloy 7001 which allows a resistance of 550 MPa thus E0.2/Msp = 220, at the cost of a risk of nonductile fracture.

More rarely, because of difficulties of use, the titanium alloys which have been hardened by precipitation are also used. The corrosive properties are excellent. Typically the alloy TA6V4 allows a resistance of 1000 MPa and thus a ratio E0.2/Msp = 1000/4.4 or approximately 230. Thus, it constitutes the best solution of the 4 described types of metal materials. However, one notes that for the titanium alloys, the commercial cost is 8 times greater than that of the reference technique, which makes these alloys difficult to produce.

The most recent techniques used employ partially metallic materials, or nonmetal materials, based on carbon fiber, in combination with, for example, glass fibers, or they use organic polymers such as the polyesters or epoxides. Their Young's moduli and their resistances vary within a broad range depending on the components and the methods. However, in commercial products having a weight which is substantially equal compared to the reference technique, one observes that they certainly have the reputation of having the same strength, but a higher stiffness, which is a drawback in the bicycle application. The products according to this technique, based on carbon fiber, glass, organic matrixes, are free of corrosion problems; the suppliers of finished products, because the observation time has been short, provide no comment on longevity.

The elementary calculation note in Appendix 1 also shows that because of the ratio Young's modulus/specific weight, which is practically invariable in the field of metal materials that are used, the flexibility depends only on the weight of the structure.

In this context of flexibility at identical equal weight, the intended purpose is to strengthen considerably the property of good resistance to corrosion, while at the same time benefiting from the high mechanical resistances, and thus from an advantageous resistance/specific weight ratio, even at competitive prices; the result is the technique according to the invention, which consists of the selection and the use of metal alloys, [on an] iron base, which have specific weights and Young's moduli that are very similar to those of the reference technique, but they comprise, among other elements which are characteristic of the analysis, at least 12% elemental chromium, stainless steels; in addition, owing to the presence of other elements, they can be hardened by various thermal or thermomechanical treatments. These stainless steels will comprise 12-27% chromium, 0.005-0.35% carbon, 0.1-20% nickel, 0.1-5% molybdenum, 0.1-9% manganese, 0.1-1.5% silicon, 0.1-4% copper, 0.1-2% aluminum, 0.005-2%

titanium, 0.005-1% niobium, 0.005-1% tantalum, 0.005-0.5% nitrogen, and other elements depending on the procedures of production of the metal.

They contribute a new set of characteristic advantages, as they are not found in combination in even one of the materials that are currently used, where the advantages are of various degrees, but at potentially very high levels and potentially for a very long duration: they guarantee simultaneously protection against the dangerous and expensive damages caused by corrosion, and higher mechanical resistances, which are obtained by cold hammering or by means of cycles of thermal treatments, or by a combination of cold hammering operations and thermal treatments, which are repeatable and thus reliable. These structures, the pieces and accessories so produced, do not have the reputation of aging excessively; they are more resistant to oxidation; they require neither an internal nor an external surface treatment, such as phosphatization, coating, anodization, galvanic deposits; they are not at risk due to invisible internal damage; they require no maintenance; and they are resistant to the shocks and scratches which usually destroy the surface treatment locally. These steels, to which one confers for their functional use a high resistance, have surfaces which lend themselves to aesthetic finishing, such as polishing or fine sanding; they present a high hardness, and thus are damaged little by shocks and friction, which in any case merely create a deficiency in the appearance. In addition, they allow a range of ratios of resistance/weight, E0.2/Msp, of 120-200, where the last value is greater than that of the conventional aluminum alloys and close to that of titanium alloys. The commercial price of the embodiment according to the technique of the invention, as it clearly depends on the industrial means used, is evaluated to be intermediate between that of the reference technique and that of the conventional aluminum alloys.

Depending on the nature of the risk of corrosion encountered, which is a function of the stresses to which the pieces are subjected during their use, depending on the wishes and functional possibilities of decreasing the weight and of bending, taking into account the intended duration of the [anti-]corrosion effect, in the field of these steels which comprise at least 12% chromium, one uses different steels characterized as indicated below:

Moderately stainless steel and very economical steels, martensitic with 13-15% chromium, 0.15-0.35% carbon, 0.1-4% nickel, 0.1-4% molybdenum, which, after a spheroidization treatment at a temperature of 875-925°C, a technique which is well known, can be properly cold worked and shaped, allowing the obtention, by a treatment of placement in solution between 925 and 950°C, followed by quenching, and tempering between 300 and 600°C, of a resistance of at least 1000 MPa, which corresponds to a ratio of E0.2/Msp of 120. Well-known steels representative of this class are Z20C13 and Z30C13.

A better performing technique uses martensitic stainless steels, stainless maraging steels, or semi-austenitic steels, which can all be hardened by formation of precipitates, with 12-18%

chromium, 0.01-0.15% carbon, 3.5-9% nickel, 0.1-3% manganese, 0.1-4% copper, 0.1-2% aluminum, 0.005-2% titanium, 0.005-1% niobium, and 0.005-0.15% nitrogen. The martensitic metallurgic character or semi-martensitic metallurgic character depends on the relative contents of elements, which are selected with precision in the indicated ranges. These steels, which in principle are in the dissolved state before cold deformation, which confers a more or less expensive cold hammering, consequently have, or allow following precipitation treatments, as a function of the precise composition, resistances that are at least in the range 1100-1600 MPa, that is E0.2/Msp ratios between 125 and 200. The steels indicated below are well known and representative. For the martensitic steels: Z6CNU17.04 with 15-17% chromium, 0.01-0.15% carbon, 3.5-5% nickel, 0.1-1% manganese, 0.1-0.6% silicon, 2.5-4% copper; Z8CND16.04 with 15-17% chromium, 0.01-0.15% carbon, 3.5-5% nickel, 0.8-1.6% molybdenum, 0.1-1% manganese, 0.1-0.6% silicon; Z5CNU15.05 with 14-16% chromium, 0.01-0.15% carbon, 4-5.5% nickel, 0.1-1% manganese, 0.1-1% silicon, 3-4% copper; Z7CNT7.07 with 16-18% chromium, 0.01-0.15% carbon, 5.5-7% nickel, 0.1-1% manganese, 0.1-1% silicon, 0.1-0.5% aluminum, and 0.5-1.2% titanium. For the stainless maragings: EZ2CNDAT12.09 with 12-13% chromium, 0.005-0.02% carbon, 8-9% nickel, 1.5-2.5% molybdenum, 0.1-0.5% manganese, 0.1-0.5% silicon, 0.5-1% aluminum, and 0.1-0.5% titanium. For the semi-austenitic steels: Z7CNA17.07 with 16-18% chromium, 0.01-0.15% carbon, 6.5-7.75% nickel, 0.1-1% manganese, 0.1-1% silicon, 0.75-1.5% aluminum; Z4CNDA14.08 with 14-16% chromium, 0.1-0.15% carbon, 7-9% nickel, 1.8-2.8% molybdenum, 0.75-1.5% aluminum; Z10CNDA15.07 with 14-16% chromium, 0.01-0.15% carbon, 6.5-7.75% nickel, 1.5-3% molybdenum, 0.1-1.2% manganese, 0.1-1% silicon, 0.75-1.5% aluminum, whose thermo-hardening cycle is characterized by their temperature plateaus, successively between 760°C and 950°C, then between +20°C and -80°C, and finally between 510°C and 565°C, or, if the steel has first been subjected to cold hammering, a single plateau between 450°C and 500°C.

In a manner which is generally better performing with respect to corrosion, but less with respect to resistance, one uses austenitic stainless steels, which are essentially hardenable by cold hammering, with 15-26% chromium, 0.01-0.10% carbon, 6-20% nickel, 0.1-5% molybdenum, 0.1-9% manganese, 0.1-1% copper, 0.1-2% aluminum, 0.005-1% titanium and niobium and tantalum, and 0.005-0.5% nitrogen. By cold hammering, they allow the obtention, depending on a precise composition and a reduction of cross section, of E0.2 = 1000-1400 MPa, and thus values of E.02/Msp of 125-175. Representatives of this type of steel are Z2CN18.10, Z2CND17.12, Z2CN17.12Az (0.25% nitrogen), or highly strengthened with manganese and nitrogen: Z5CNMD18.06Az (8% manganese, 0.4% nitrogen).

One can also use austeno-ferritic steels, which in addition to their good resistance to corrosion, have a good capacity to harden by cold hammering, with 22-27% chromium,

0.005-0.10% carbon, 2.5-7% nickel, 0.1-4% molybdenum, 0.1-7% manganese, 0.1-2% copper, 0.005-0.25% nitrogen, which allows the obtention, by cold hammering, of a resistance of 1000-1250 MPa, and thus the ratios E.02/Msp are 125-155. Representatives of this class of steels are Z2CN23.04Az, Z2CND22.05Az, Z2CND25.07Az.

Other objects of the invention are the usage operations, as a function of the material, of the desired characteristics, and the available industrial means, which will be described below:

As far as soldering is concerned, when soldering is used to manufacture elements, for their assembly, or to fix couplings, the TIG method is considered a particularly interesting example. One can also use any other type of soldering, such as soldering by Joule effect, using direct current, alternating current at all rates, alternatively at all frequencies. Soldering with any type of filler rod. Or soldering by pressure, or white forging, after induction heating or heating by means of any other electrical furnace, gas, fuel, coal or wood furnace. Advantageously, in some contexts of this sequence of operations, one can use the single phase or the first phase of the hardening thermal treatments, on the soldering seam, exploiting the required increase in temperature, first to decrease the resistance of the sheath, and thus to facilitate its shaping, for example, to a cylindrical shape, then as a soldering preheating, which can result in a gain in quantity and increased soldering speeds, and finally as a normal treatment for hardening the alloy used.

If the semifinished metallurgic product is a metal sheet or a metal strip, the shaping will be carried out by impact-cutting, cold hammering, hammering, rolling, dies, and attachment by stapling, riveting, gluing, soldering of all types, brazing of all types, which may be geometrically continuous or discontinuous; the list is not comprehensive.

If the semifinished product is not hammered or is hammered little, it will be hammered more in the final shaping, by drawing, by pilgrim cold rolling, all methods which are well known to confer a cold hammering effect and a good dimensional precision to the product of the transformation.

If the material is to be hardened by precipitation, after placement in solution and possible cold hammering, and if it has not been processed so before the shaping, it will undergo the processing later, optionally even after installation. This will be the case, in particular, for structural elements consisting of tubes without soldering or tubes which have been soldered, hammered, obtained by cold deformation as described above and which are ready for the final assembly or which are assembled.

A supplementary moderate cold hammering can also be carried out during the hardening to improve the dimensional precision, which facilitates the placement during fitting. This approach is advantageously applied to the ends only by a precise constriction using matrixes.

The assembly connections, which in the vocabulary of the cycling profession, are called connections for the steering tube, the seat tube, the crankset casing, the grease channels, the fork crown, in a list which is nonlimiting, can be prepared from the same material, or a similar material, which lends itself for use in these manufactured pieces, or from a material which is resistant to alteration and presents the required strength, and is compatible with the material of the structure from the point of view of electrochemical corrosion.

The elements of the structure and/or the assembly connections, to the extent that they undergo during the course of their use a crystallographic transformation, which is accompanied by variation in the dimensions, can be assembled exploiting these dimensional variations, the minima for the shaft and the maxima for the boreholes, to obtain, owing to clearances, easy fitting operations, and then effective tightening.

The fitting of the elements in the connections can be carried by cooling below the ambient temperature, where either the entire component or only its end enters. If the thermal hardening cycle comprises a cold plateau, it can be used during the mounting, in a single operation, where the fitting operations are then carried out while the entering male parts are in the minimum temperature phase of the cycle of the thermal hardening treatment. The result will be an easier installation and also improved tightening. Excessive cooling of the ends alone can promote the assembly clearances, the tightening and, in the case of some materials, it can promote a local increase in resistance, which is advantageous in these critical areas close to the connections.

It is economically advantageous to take into account for the selection of materials, steel, brazing or glue, temperatures of use which are compatible, as much as possible, and allow one, for example, to carry out in a single step the heating required for at least two of the successive operations, if they are necessary, of preheating before soldering, tightening by changing the crystallographic parameters, brazing, gluing and hardening.

Below, nonlimiting examples are described for the objects, the steels, the methods, the means, the dimensions, the reductions in section, and possible industrial applications.

Considering the steel Z10CNDA15.07, as defined above, one can carry out the following manufacturing sequences, starting with a metal strip having a thickness of 0.5 mm, TIG soldering without additional metal or with additional metal, but in the latter case the additional metal is advantageously the same type of steel, to manufacture a cylindrical tube having a diameter of 48.3 mm. In the first option, one proceeds within the same operation, that is on the soldering line, to the thermal treatment by inductive heating and any other means appropriate to heat to the known temperatures required for this steel, according to the instructions of the manufacturers, where the temperature program consists in first heating it to 760°C and 950°C, then to a temperature between 20°C and -80°C, and finally to a temperature 510-565°C. The

constitutive elements of the structure to be manufactured having thus been sectioned, they can be assembled and fixed by gluing or brazing at a temperature less than or equal to that chosen for the proceeding heating. In a second option, only the first temperature plateau between 760°C and 950°C is carried out in a first step, that is, in the soldering line, a second option between +20 and -80°C is used to arrange assembly sets of larger size and/or to achieve a better tightening in the connections; the third option, between 510 and 565°C, occurs simultaneously with the brazing or gluing after assembly. In a third option, the thermal treatment is not carried out in the soldering line at all; the cutting into sections is carried out after the soldering of the tube; and then the assembly by TIG soldering is carried out, using an identical additional metal or a general base metal, but not necessarily, or brazing which is compatible with the subsequent temperature, and the entire assembled structure will be treated at the prescribed temperatures. In this manner, it will be possible to reach values of E0.2 of 1300-1600 MPa, which is equivalent to an E0.2/Msp ratio between 160 and 200, with very reliable metallurgical bonds.

It is also possible to use a metal strip made of the same steel, having a thickness of 1 mm, to weld a cylindrical tube having a diameter of 50 mm. One then proceeds to carry out on this tube a reduction in cross section between 20 and 60%, by cold rolling, of the pilgrim type, and, in this case, advantageously on an internal mandrel having a low slope that is less than 2%, which is thus nearly cylindrical, or by drawing from another dimension of the soldered tube adapted for this purpose, one can cold hammer the material by deforming it to a diameter of 48.3 and a thickness of 0.5 mm. In the first option, the procedures of lamination or drawing are carried out on the production line, or in an independent operation, depending on what is economically more advantageous, at a temperature of 450-500°C, which confers properties of resistance to the material, then, after sectioning, one proceeds to the assembly by gluing or brazing at a temperature less than or equal to 450°C. In the second option, one cuts the sections immediately after the cold working; one assembles them, preferably by a treatment at 450°C which is carried out simultaneously with the brazing or the gluing. In the third option, the hammered, sectioned tube is used as is, and the bonds are fixed by gluing. The resistances can thus reach 1600 MPa, which is equivalent to a ratio E0.2/Msp of 200. This allows one to consider, for the same resistance of the structure, increases in weight which in theory can reach 50%, which means that this embodiment is more advantageous than the carbon-based products, as it additionally provides the advantages of elasticity.

Appendix 2 illustrates the different possibilities which have been described, but in a nonlimiting manner; other approaches can be derived from the same invention. Compared to the careful manufacturing process of the reference technique, the commercial price, as a function of the industrial means used, can be approximately 50% higher, thus less than that of the aluminum alloy technique.

Using the same steel, still taken as a nonlimiting example, it is possible to obtain from a blank by punching-cutting, stamping, pressure of an elastomer, fluid or gas, explosion, a complete structure, or two nearly symmetrical semi-structures to be assembled by soldering, staples, point electrical soldering, or any other connection means, which can by the already invoked thermal treatment constitute, for example, a resistant bicycle frame, using a minimum of operations.

Other embodiments are possible, for example using an austeno-ferritic steel, as defined above, in the form of a metal strip having a thickness of 1.5 mm, by soldering a tube having a diameter of 51 mm, which will be hammered to a 20-60% reduction of the cross section, by cold rolling, in particular on a mandrel having a low slope as described above, or by drawing from another soldered tube having an adapted dimension. The hammered tube will be sectioned, assembled, and the structure will be fixed by gluing or any other connection means which does not require a temperature above 400°C, a constraint which is imperative for this type of steel because of the formation of a metallurgical phase between 400 and 500°C, which results in fragility. It is possible to obtain a resistance of 1000 MPa, equivalent to E0.2/Msp = 125, at a commercial price which is on the order of 20% higher than that of the referenced technique. Appendix 3 illustrates these possible variants of the manufacturing sequences; however, many others are possible without going beyond the scope of the invention.

- Strength:

It is advantageous to characterize the strength with reference to the weight, which itself is proportional to P

$$S = 3.14 \times D \times Ep \times Eo.2$$

$$Ep = P/(3.14 \times D \times Msp)$$

$$S = 3.14 \times D \times P/(3.14 \times D \times Msp) \times Eo.2$$

$$S = P \times Eo.2/Msp$$

$$S/P = Eo.2/Msp$$

This parameter allows the classification of the materials as a function of their strength/weight performance.

	1 Acier carbone ecroui-brasé		2 Acier allié	3 Dural	4 Aciers inoxyd	5 Alliages titane
Eo.2	400	200	800	400	1000-1600	1000
Msp	8.		8.	2.7	8.	4.4
Eo.2/Msp	50	25	100	150	125-200	230

Key:
1 Hammered-brazed carbon steel
2 Alloyed steel
3 Dural
4 Stainless steels
5 Titanium alloys

Example of application: case of Dural, compared to the moderately alloyed steel of the reference technique, 25CD4:

Ratio of the cross sections:

- at equivalent strength:

  800/400 = 2

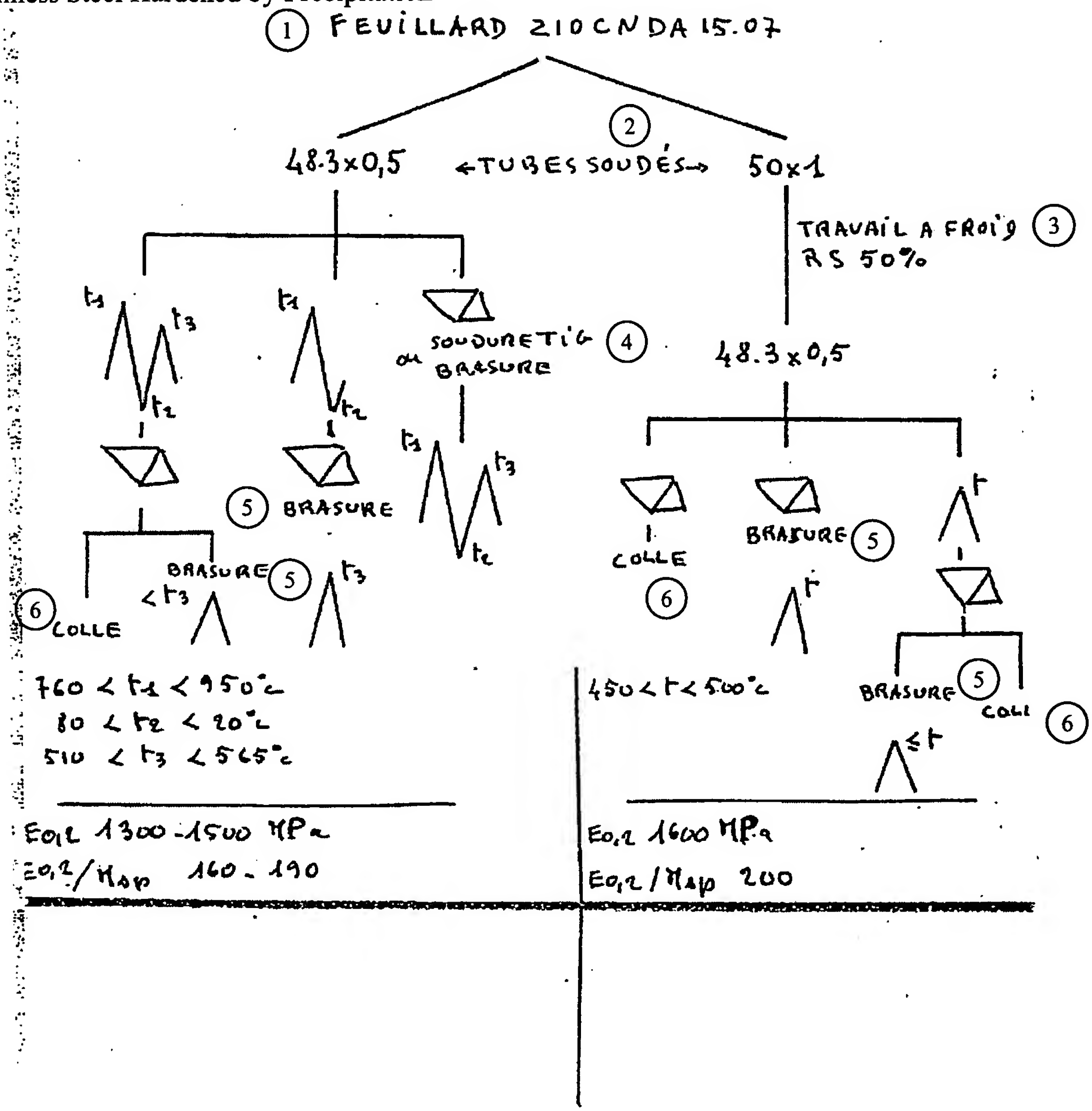
- at equivalent stiffness:

  210,000/70,000 = 3

one can indeed note that in the commercial products, there is a slight increase in weight, and even a slight excess weight, depending on the options chosen by the manufacturer.

Appendix 2*

Stainless Steel Hardened by Precipitation



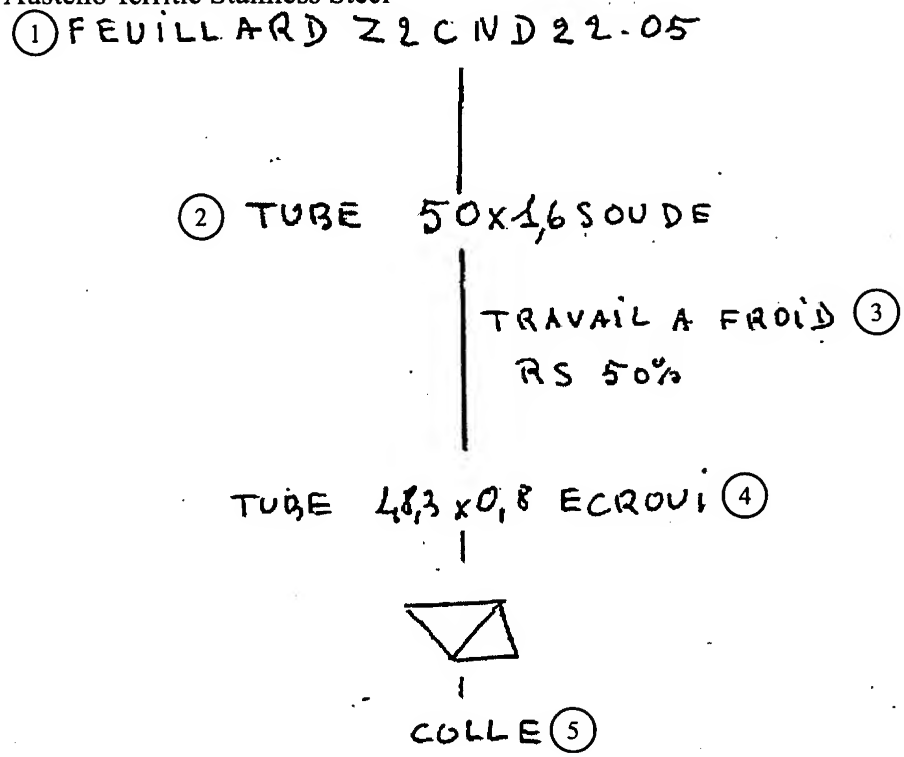
Key:

1	Metal strip
2	Soldered tubes
3	Cold work RS [reduction in cross section] 50%
4	TIG soldering, or brazing
5	Brazing
6	Glue

* [Note: Both periods and commas seem to be used interchangeably in numeral to denote decimal place.]

Appendix 3

Hammered Austeno-ferritic Stainless Steel



E0,2 1000 MPa

E0,2/Msp 125

Key:	1	Metal strip
	2	Tube 50 x 1.6 soldered
	3	Cold work
	4	Tube 48.3 x 0.8 hammered
	5	Glue

Claims

1. Apparatuses, their components and their accessories, equipped with wheel(s), such as wheelbarrows, carts, bicycles, tricycles, motorcycles, quadricycles, for urban or all-terrain use, notably their chassis, skids, frames, rims, spokes, bracing wires, hubs, axles, tubes for seats, handlebars, cranks, chains, cables, engaging connection parts, fastenings, characterized in that their material is a stainless steel with 12-27% chromium, 0.005-0.35% carbon, 0.1-20% nickel, 0.1-5% molybdenum, 0.1-9% manganese, 0.1-1.5% silicon, 0.1-4% copper, 0.1-2% aluminum, 0.005-2% titanium, 0.005-1% niobium, 0.005-1% tantalum, 0.005-0.5% nitrogen, and other elements depending on the procedure of production of the metal.

2. Apparatuses, their components and their accessories, according to Claim 1, characterized in that the steel is of the martensitic type with 13-15% chromium, 0.15-0.35% carbon, 0.1-4% nickel, 0.1-4% molybdenum, which are worked and cold shaped after a spheroidization treatment at a temperature of 875-925°C, then hardened by a treatment of placement in solution at 925-950°C, quenching, and tempering at 300-600°C.

3. Apparatuses, their components and their accessories, according to Claim 1, characterized in that the stainless steel is martensitic stainless, or stainless maraging, or semi-austenitic, with 12-18% chromium, 0.01-0.15% carbon, 3.5-9% nickel, 0.1-3% molybdenum, 0.1-4% copper, 0.1-2% aluminum, 0.005-2% titanium, 0.005-1% niobium, 0.005-0.15% nitrogen, where the steels are dissolved before cold deformation producing a cold hammering effect, which steels are hardenable by precipitation treatments, depending on the exact composition.

4. Apparatuses, their components and their accessories, according to Claim 3, characterized in that the steel comprises 14-16% chromium, 0.01-0.15% carbon, 6.5-7.75% nickel, 1.5-3% molybdenum, 0.1-1.2% manganese, 0.1-1% silicon, and 0.75-1.5% aluminum, whose thermal hardening cycle is characterized by three successive temperature plateaus, between 760°C and 950°C, between +20°C and -80°C, and then between 510°C and 565°C, or if the steel has been hammered beforehand, a single plateau between 450 and 500°C.

5. Apparatuses, their components and their accessories, according to Claim 1, characterized in that the stainless steel is austenitic, with 15-26% chromium, 0.01-0.10% carbon, 6-20% nickel, 0.1-5% molybdenum, 0.1-9% manganese, 0.1-1% copper, 0.1-2% aluminum, 0.005-1% titanium and niobium and tantalum, and 0.005-0.5% nitrogen, hardened by cold hammering.

6. Apparatuses, their components and their accessories, according to Claim 1, characterized in that the stainless steel has an austeno-ferritic structure, with 22-27% chromium, 0.005-0.10% carbon, 2.5-7% nickel, 0.1-4% molybdenum, 0.1-7% manganese, 0.1-2% copper, 0.005-0.25% nitrogen, hardened by cold hammering.

7. Apparatuses, their components and their accessories, according to Claims 2, 3, 4, characterized in that a shaping of the metal is carried out during the increase in temperature in one of the phases of the thermal hardening treatment.

8. Apparatuses, their components and their accessories, according to Claims 2, 3, 4, characterized in that the fitting operations are carried out while the entering male parts are in the minimum temperature phase of the thermal hardening treatment cycle.

9. Apparatuses, their components and their accessories, according to Claim 1, characterized in that the manufacture of a cylindrical tubular component is carried out from a blank made from a rolled-soldered metal strip, cold rolled using a pilgrim cold rolling machine, on a near cylindrical internal mandrel having a slope of less than 2%, where the reduction in cross section is between 20 and 60%.

10. Apparatuses, their components and their accessories, according to Claims 1, 2, 3, 4, characterized in that the fitting operations are carried out while the entering male parts are at the minimum of variations in size connected with the crystallographic transformations during the phases of the thermal hardening treatment.